

***Biston betularia* L.(Lep. Geometridae): continued decline in Industrial Melanism in north-west Kent**

This is a third update of the paper published in *Ent. Rec.* **100**: 39, previously updated in *Ent. Rec.* **102**: 175, and again in *Ent. Rec.* **106**: 229. Since 1994, *f. typica* has continued to increase in incidence and *f. carbonaria* Jordan to decrease, both now more slowly and with a tendency towards levelling out. Thus, in the nine years 1994 to 2002, *f. typica* has increased by 16% from about 42% to 58% and *f. carbonaria* has declined in incidence by a corresponding amount from about 24% to 8%. During this period, *f. insularia* Th. – Mieg has averaged 31.7% commencing and finishing the period, at about 34% (Table 1; Fig. 1).

**Table 1.** Annual occurrence (percentage of total catch for the species) of the three main forms of *Biston betularia* at Dartford, Kent.

Year	<i>f. typica</i> (%)	<i>f. insularia</i> (%)	<i>f. carbonaria</i> (%)	number in sample
1994	42.5	33.75	23.75	80
1995	50.0	26.5	23.5	102
1996	52.0	25.5	22.5	134
1997	63.0	26.0	11.0	138
1998	54.6	33.7	11.7	163
1999	53.7	35.8	10.5	67
2000	51.0	40.0	9.0	55
2001	57.5	32.0	10.5	66
2002	58.0	34.0	8.0	76

Since *f. typica* and Kettlewell's *f. insularia* are virtually indistinguishable from one another the relative incidence of both *typica* and *insularia* must be questionable, but there is no such reservation regarding *carbonaria*. In industrial areas such as north-west Kent, this particular problem is made more difficult due to specimens of *typica* being more heavily marked, in general, than those from the extreme west of Britain and other localities far from the polluted atmospheric environments of industrial regions. Thus, specimens I possess from Grantown-on-Spey, Moray, are much more lightly marked than any specimen I have seen in north-west Kent.

The early stages of the development of industrial melanism received relatively little attention, but collections made at the time have provided useful information. Kettlewell (1973. *The Evolution of Melanism*), has shown that early in the process many *carbonaria* possessed a whitish post-median line on the forewing, and a white patch anteriorly on the hind wing. A number of such specimens has occurred here before 1990, particularly in the 1980s. In the period since 1994 only one has been observed.

It was considered that *carbonaria* was completely dominant genetically over *insularia*, and that both were dominant over *typica*. However, the situation is slightly more complex and *insularia* is only partially so affected, and so the masking effect demonstrated in the phenotypes is not complete, although it is to a great extent. There are two consequences of this. Firstly, as *carbonaria* has increased in the *betularia* population, *insularia* if present has decreased, but the *insularia* genes

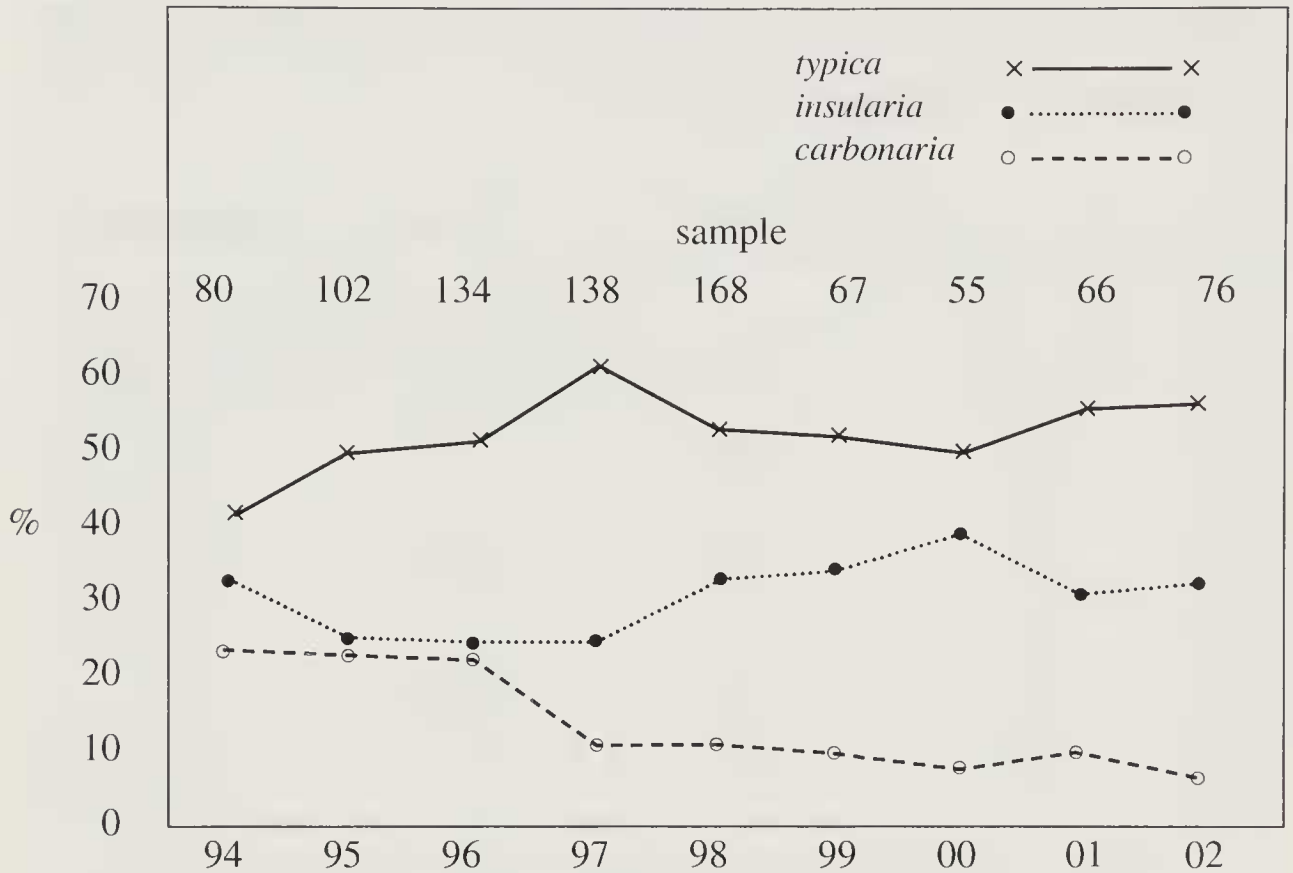


Figure 1. Incidence of forms of *B. betularia* 1994 to 2002 inclusive.

remain. So, with the decline in industrial melanism the *insularia* genes increasingly become effective and *insularia* phenotypes become commoner. Kettlewell (*op. cit.*) has pointed out that Haldane had concluded that high values of *insularia* are associated with *carbonaria* figures of 10% to 30%. In north-west Kent for the past nine years just such a condition has obtained, the incidence of *carbonaria* having fallen from 78% in the period 1970-1973 to between 24% and 8% each year from 1994 to 2002 (Table 2; Fig. 2).

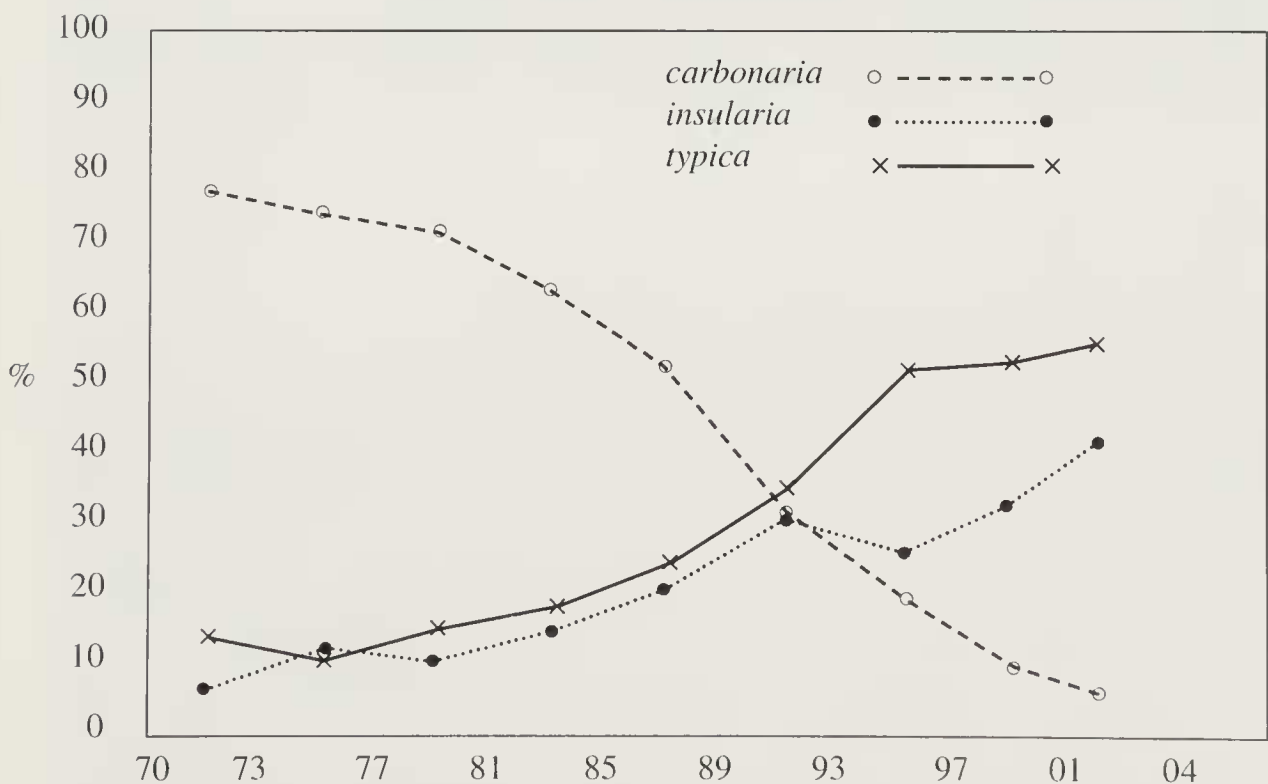
Atmospheric pollution caused the disappearance of lichens from trees in the local woodlands and elsewhere in the late 19th century and the darkening of fences and vegetation; from this change in environment developed the change in incidence of the forms of *B. betularia* and other moths. Lichens are returning to trees in north-west Kent, but are still not much in evidence. Tree trunks, other than those blackened by fire, are often greenish due not to lichens, but to the alga

**Table 2.** Occurrence (percentage of total catch for the species) of the three main forms of *Biston betularia* at Dartford, Kent, analysed by four-year periods, 1970-2001

year group	f. <i>typica</i> (%)	f. <i>insularia</i> (%)	f. <i>carbonaria</i> (%)	number in sample
1970-73	14.5	7.5	78.0	119
1974-77	10.5	13.0	76.5	107
1978-81	17.0	11.0	72.0	99
1982-85	19.0	16.5	64.5	102
1986-89	25.0	21.0	54.0	164
1990-93	36.5	31.0	32.5	119
1994-97	51.9	27.9	20.2	113
1998-01	54.2	35.3	10.5	88

*Pleurococcus*. On these trees, *carbonaria* are disadvantaged and so have declined in incidence, while *typica* are at an advantage; *insularia* are particularly suited to the *Pleurococcus*.

The polymorphism of *B. betularia* in 2002, with high incidence of *typica* and *insularia*, and a low incidence of *carbonaria*, has doubtless resulted from the clean air legislation and its environmental effects in north-west Kent. However, these ratios have arisen elsewhere by another route.



**Figure 2.** Incidence of forms of *B. betularia* over four-year periods, 1970-2001 and 2002.

The slightly incomplete dominance of *carbonaria* over *insularia* is demonstrated by occasional specimens occurring which possess the wing markings of *insularia* and the black thorax and body of *carbonaria* and are supposedly of mixed *insularia* x *carbonaria* origin. These are ab. *mixtus* Voss. They retain the white spot at the base of the forewing as do *carbonaria* in north-west Kent, and a largely white head. The intensity of the speckling on the wings is usually commensurate with that on the thorax and body in *insularia*, but in *mixtus* the occasional lightly marked specimen with black thorax and body gives a distinctly incongruous, almost bizarre effect. The exact genetic nature of ab. *mixtus* seems not to have been noted in the entomological press, but it is unlikely to be the outcome of any random pairing of the two phenotypes, *insularia* and *carbonaria*, for it is too rare. Ab. *mixtus* has been included with *insularia* in the accompanying Figures and Tables since in earlier years I was not aware of its separate identity.

Despite the slowing down in the changes in the incidence of the forms of *B. betularia* in north-west Kent, it seems unlikely that the moth will become monomorphic in the foreseeable future with *typica* prevailing, as it did before the industrial revolution and as is thought to be likely in such industrial states as Michigan and Pennsylvania in the U.S.A. In some semi-polluted areas in Britain there is a high incidence of both *typica* and *insularia*, and a much lower incidence of *carbonaria* – somewhat resembling the situation at Dartford to-day. In both, *Pleurococcus*-covered tree trunks and branches prevail and growth of lichens may increase; atmospheric pollution is in decline. In such regions the species may tend towards dimorphism and remain dimorphic for a long time.

I wish to thank B.S. Grant of the College of William and Mary, Williamsburg, Va., U.S.A. for sending me a copy of his work on melanism in the *Journal of Heredity*, and other literature.— BRIAN K. WEST, 36 Briar Road, Dartford, Kent DAS 2HN.

### **An unlikely Sutherland crambid was an Oecophorid!**

A micro at first thought to be *Donacaula forficella* (Thunberg), flying commonly in Gleann Dubh (O. S. grid reference N0 2622 to NO 2621) at Inchnadamph, Sutherland on 7 July 2001 (Ent. Rec. **114**: 41-43), proved to be *Pleurota bicostella* (Clerck). The female specimen I netted laid seventeen eggs in a plastic box and was sent to Tony Davis of the Pyralid and Plume Recording Scheme five days later. He was not able to reply until March 2002 identifying the moth as the oecophorid, which I. R. P. Heslop aptly named the Light Streak. Mark Young had written to me a few weeks earlier stating that *P. bicostella* was a likely candidate as the first time he saw the species near Braemar he, too, mistook it for a crambid. My misidentification would not have been made if the excellent illustrations in *The Moths and Butterflies of Great Britain and Ireland*, vol. 4, part 1 had been published a year earlier.— D. C. HULME, Ord House Drive, Muir of Ord, Ross-shire IV6 7UQ.